UNITED
NATIONS

ST

Secretariat

Distr.
GENERAL

ST/SG/AC.10/C.3/20/Add.1
4 August 1995

ENGLISH ONLY

COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS

Sub-Committee of Experts on the Transport of Dangerous Goods

REPORT OF THE SUB-COMMITTEE OF EXPERTS ON ITS TENTH SESSION
(Geneva, 10 - 20 July 1995)

Addendum 1

Report of the Working Group on Portable Tanks

(see also ST/SG/AC.10/C.3/20, paras. 14 to 33)

GE.95-23231

Report of the Working Group on Portable Tanks

1. The Working Group on Portable Tanks reconvened during the tenth session of the Sub-Committee of Experts on the Transport of Dangerous Goods (10-14 July 1995) Dr. Schulz-Forberg (Germany) served as Chairman of the group. He provided a provisional agenda which covered: a second reading of paragraphs 12.19.3 through 12.23.2; outstanding issues regarding the liquid portable tanks (e.g. papers addressed in square bracketed text); the rationalized approach developed by the United States (-/R.618); the requirements for portable tanks intended for the transport of pressure liquified gases; and other portable tank matters identified by the Sub-Committee. Experts from France, Germany, Norway, Netherlands, Sweden, Switzerland, United Kingdom, United States and OCTI attended the meeting. The agenda was accepted by the Working Group (see annex 1).

2. The following is a summary of the group's discussions and proposed amendments to ST/SG/AC.10/C.3/R.595/Add.1 based on agenda item 1:

(a) In paragraph 12.19.3.4, the group agreed to the following text: "Portable tanks, empty and uncleaned, may be moved after the expiration of the 5 year interval. In addition, the 2.5 year inspection and test may be carried out within 3 months before and after the specified date".

(b) In paragraph 12.19.3.7, the words "by an expert approved by the competent authority", was replaced by "by the competent authority or its authorized body".

(c) In paragraph 12.19.3.8, the words "at least" were deleted.

(d) Paragraph 12.19.7 was renumbered as 12.19.4.

(e) In paragraph 12.20.1, the word "plate" was replaced with "place". The words "for the design approval" were inserted after Authorized Body.

(f) In paragraph 12.23.2, the group took note of a recent amendment agreed to by the Joint Meeting. The group agreed to add the text "(e) dangerous rise in pressure". The words "the same or" were deleted. The square brackets were deleted.

3. The group then turned to outstanding issues, questions and square bracketed text. The Chairman summarized and prioritized the issues, taking into account comments from the experts from Belgium and Argentina who were not present, comments provided by the IMO Working Group on Portable Tanks in ST/SG/AC.10/C.3/R.629 as well as several other papers submitted (ST/SG/AC.10/C.3/R.608, -/R.621, -/R.624, INF.4, INF.5, INF.29). The following is a summary of the discussions on these matters.

4. In regard to tank types, the group agreed to defer discussions of decisions to adopt tank types until the Sub-Committee makes a decision on the rationalized approach to assigning portable tank requirements as well as the means for identifying tank requirements for specific substances in the reformatted UN Recommendations. The representative of OCTI stated that the rationalized approach should establish the basis for developing tank types.

5. A few editorial amendments were agreed to:

In paragraph 12.3.11.1 the word "maximum" was deleted.

In paragraph 12.4.2, the reference to 12.5.6 was changed to 12.5.5.3.

6. The expert from Germany provided a presentation on the wording placed in square brackets in paragraph 12.19.1 [the substances or groups of substances allowed to be transported].He explained that it was his opinion that substances or group of substances need not to be included on the design certificate. He explained how the restructured RID/ADR and the existence of the BAM list would eliminate the necessity for listing the substances or groups of substances permitted for transport in portable tanks. He provided an example of a German tank approval certificate as well as excerpts from the BAM list to illustrate how design approvals were issued in Germany. He stated that the design certificate should refer to a system for assigning substances to portable tanks.

7. The Chairman summarized the matter and asked the group whether it could support deleting the square brackets in 12.19.1. He stated that he believed the current wording, which indicates that "the certificate should refer to the substances or group of substances allowed to be transported", did not necessitate the inclusion of a list of substances or group of substances on the design certificate. Although the majority of group members were in agreement that the certificate should not include a list of substances, some members preferred to delete the brackets as well as the words within the brackets. The group could not reach a conclusion on

this matter and the text was left in square brackets. The Chairman will address the matter to the Sub-Committee.

8. The group then turned to the matter of the leakage test. The expert from the United States provided information from the Tank Container Association (TCA) and an independent test agency within the United States. He recommended that the test pressure specified for the leakage test (75 % MAWP) be revised to 25-50% (MAWP). The group took note of the comments by the IMO tank group which did not oppose lowering the test pressure and the following text was agreed to:

> "12.2.9 Leakage test means a test using air or inert gas which consists of subjecting the shell and its service equipment to an effective internal pressure equivalent to not less than 25 percent of the maximum allowable working pressure but not more than 50 percent of the maximum allowable working pressure."

9. Based on a paper (INF.4) submitted by Germany, the group agreed to incorporate a provision to allow the use of explosion pressure proof portable tanks in lieu of tanks equipped with flame traps for portable tanks intended for the transport of Class 3 liquids or elevated temperature materials transported at temperatures above their flashpoint. The words "or the tank should be explosion pressure proof" were added in square brackets at the end of paragraph 12.3.10 pending the submission of definitions for "explosion pressure proof" and "flame trap" from the expert from Germany.

10. In regard to the square bracketed text in paragraphs 12.5.3 and 12.5.4 covering minimum shell thickness, the proposal -/R.621 (United-States) was considered. The group agreed by a majority to adopt an absolute minimum thickness of 3 mm regardless of the material of construction for portable tanks. In 12.5.2 the last sentence was deleted. Paragraph 12.5.3 was amended as follows:

> "12.5.3 Where additional protection of the tank ... if of other metal."

A new paragraph 12.5.4 was added as follows:

> "The cylindrical positions, ends and manhole covers of all the tanks should be not less than 3 mm thick regardless of the materials of construction."

The brackets were deleted from 12.5.4 and 12.5.5. These paragraphs were renumbered 12.5.5 and 12.5.6.

11. In regard to sacrificial devices, the group agreed to adopt the proposal by the IMO tank group with minor editorial amendments as follows :

> "12.6.1 Service equipment should be arranged, protected or constructed to reduce the risk of damage during transport and handling. The external filling and discharge fittings (e.g. pipes, outlets and bottom openings), should be constructed to avoid any loss of the tank contents in the event of damage. If the connection between the frame and the tank shell allows relative movement between the sub-assemblies, the equipment should be so fastened as to permit such movement without risk of damage to working parts. The external discharge fittings (e.g. pipe sockets, lateral shut-off device), the internal stop-valve and its seating should be protected against the danger of being wrenched off by external stresses (e.g. using shear section). The filling and discharge devices (including flanges or threaded plugs) and protective caps (if any) should be capable of being secured against any unintended opening".

12. Paragraph 12.6.9 of the text in -/R.595/Add.1 was deleted.

13. The expert from the United States explained the proposal in -/R.618 concerning bottom openings. He explained that in the rationalized approach for the assignment of tank requirements, the exceptions for using self closing internal stop valves for highly viscous and certain crystallisable substances was proposed to be deleted. Group members explained that this proposal could cause problems for the transport of molten substances, viscous preparations such as adhesives and other substances which tend to clog the internal valves (e.q. tar and bituminous substances). The majority of the group was not in favour of deleting the exceptions for highly viscous or crystallisable substances.

14. In regard to the statement made by the Chairman in -/R.595, the Chairman withdrew his statement. The expert from the United-States informed the group that the issue of when frangible disks should be used was covered in -/R.618.

15. In regard to paragraph 12.13.2.1 the group agreed that the insulation coefficient F should not be less than 0.25. This matter will be rediscussed in relation to the requirements for tanks intended to transport Class 2 substances.

16. The Chairman explained that is was clearly decided by the group at the previous meeting to incorporate a 4g impact test. He stated that the group should only consider the adequacy of the text used to describe the test method. He explained that, in his opinion, the test method should be general because the standards referenced in the bracketed text should be used to provide the details. He stated that additional standards could be added based on the review and approval of the Sub-Committee. The group agreed with this approach. The expert from the United States explained that he had contacted the ISO TC 104/SC2/WG4 Technical Working Group Chairman and provided him with data on test procedures. The ISO group will convene this fall to discuss development of a 4g impact test.

17. The following is the revised text :

"12.19.2 The prototype test report for the design approval should include at least the following :

- the results of the applicable frame work tests specified in ISO 1496-3;1995
- the results of the impact test in 12.19.2.1 when applicable;
- the results of the initial inspection and test in 12.19.3.1.

[12.19.2.1 For portable tanks meeting the definition of a container in the CSC, a prototype tank of each design should be subjected to an impact test. The prototype tank should be shown to be capable of absorbing the forces resulting from an impact equivalent to at least 4 times (4 g) the maximum gross mass of the loaded tank at a duration typical of the mechanical shocks experienced in rail transport. The following is a listing of standards describing methods acceptable for conducting the impact test:

Association of American Railroads
Manual of Standards and Recommended Practices
Specifications for Acceptability of Tank Containers (AAR.600)

Canadian Standards Association
Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods (B620-1977)]"

18. The group considered the proposal INF.5 (Germany) concerning reference mild steel. The expert from Germany explained the necessity to define a range of values to be used for mild steel to alleviate the need to perform equivalent thickness calculations for materials which fall within a range of strengths (360 N/mm^2 to 440 N/mm^2). Several members stated

that a single reference value should be maintained for use in calculating minimum thickness. It was also stated that the absolute minimum elongation at fracture should be maintained (20%). Some representatives supported allowing tank designs to use the minimum thickness values from Table 12.2 without having to perform calculations for steels falling within the range prescribed in the German paper. Some members supported amending the definition of reference mild steel. A small group of members agreed to draft text for the group to review, however since the group could not come to agreement the German delegation was asked to revise their paper for consideration at the next meeting. The group agreed that the term "reference mild steel" should be shown as "reference steel" since the value is not representative of a particular mild steel. The group felt that the values provided are reference values.

19. The group considered it necessary since several issues remained unresolved to ask the Sub-Committee to take notice of the report especially those items still in square brackets. The Sub-Committee should consider these issues during the first day of the eleventh session.

20. The group began the first reading of the gas papers using -/R.646 (France) as a basis for discussion and -/R.450 for background. The expert from France introduced -/R.646.

21. The group agreed that it would deal only with non-refrigerated pressure liquefied gases and refrigerated liquified gases only and not compressed gases. The expert from OCTI noted that the Recommendations do not provide requirements for compressed gases to be transported in portable tanks.

22. The expert from the United States introduced an informal paper providing a comparison of technical codes. The chairman recommended that the use of technical codes be considered separately for liquid and gas tanks. The group agreed that liquid tanks could be designed and constructed in accord with any technical code approved by the competent authority. Technical codes for gas tanks will be discussed further at the next meeting.

23. The group agreed to paragraphs 12.1 through 12.24.1 in the French paper (-/R.646).

24. In regard to paragraph 12.24.2, the expert from the United States recommended that the group consider a lower limit of 450 litres for portable tanks intended to transport substances of Class 2 (non-refrigerated liquefied gases). The Chairman agreed that in developing multimodal tank requirements this made sense. Several representatives noted that the IMDG Code uses 1,000 litres and that RID/ADR will include a 1,000 litres limit from

1 January 1997. Others supported the United-States proposal since it was in line with the division between non-bulk and bulk packagings. The Sub-Committee will be asked to consider this matter. The group agreed to place 1,000 litres in square brackets.

25. The words "Type 5" were deleted pending a decision on tank types.

26. In paragraph 12.24.2, the words "intermediate bulk containers (IBCs)" were deleted. The words "large receptacles" were added. The United States representative asked the group to consider adding the words "gas cylinders", the representative from OCTI recommended adding "tubes". These were not adopted.

27. Paragraphs 12.24.3 to 12.24.5 were adopted.

28. Paragraph 12.24.6 covering MAWP was discussed by the group. The expert from OCTI expressed concern with regard to taking into account the partial pressures covered in paragraph 12.24.6.2.2.2. He stressed that these pressures should not be considered since they were not always known when designing the tanks. He felt that there would be difficulty in adopting this provision in RID/ADR. The expert from the United States suggested that an upper pressure limit be established for the MAWP. He suggested 40 bar. The expert from France stated that the 40 bar maximum allowable working pressure was not adequate. Difluoromethane, UN 3252, which has an MAWP of 43 bar was used as an example of a substance with an MAWP > 40 bar. The representative from the United States then proposed 50 bar. Some members opposed this, but the figure was incorporated in the paper within square brackets. The group accepted a lower MAWP value of 7 bar.

29. In paragraph 12.24.6.2.2.1, the group agreed to delete the words "of air or other".

30. The expert from the United States stated, for gas tanks, the MAWP and design pressure are normally equivalent. Several members agreed. However, paragraph 12.24.6A (renumbered 12.24.7) was adopted as proposed. The Chairman asked the group to consider incorporating test pressure values into the Table 12.1 as opposed to MAWP. Text similar to the following should be added "(c) the required minimum test pressure as specified in Table 12.1 divided by [1.5]" if the group comes to a final agreement on this matter.

31. In regard to the definition for test pressure in 12.24.7 (renumbered 12.24.8), the expert from the United States requested that the figure 1.3 be replaced by 1.5. This was not accepted by the majority of participants therefore, 1.3 was placed into brackets. The Chairman

noted that the safety margin for gas tanks should not be less than the safety margin for liquid tanks. He asked the expert from F nce to explain why a 1.3 safety margin should be used. He stated that it was a historical issue. The Chairman reminded the group of the philosophy used in the tank harmonization which involves discussing and evaluating the most conservative requirement from each of the existing regulations. This matter is related to the general discussion.

32. Paragraphs 12.24.7A and 12.24.8 were adopted and renumbered 12.24.9 and 12.24.10 respectively.

33. The group agreed to accept the provisions adopted for the leakage test in the liquid paper. The following text was adopted for 12.24.9 (renumbered 12.24.11):

> "12.24.11 Leakage test means a test using gas which consists of subjecting the shell and its service equipment to an effective internal pressure equivalent to not less than 25 percent but not more that 50 percent of the maximum allowable working pressure". The words "The procedure..." were deleted.

34. In 12.24.10 (renumbered 12.24.12), the group agreed to adopt the same text as provided in 12.2.10 (-/R.595/Add.1).

35. In regard to 12.24.11 (renumbered 12.24.14), the expert from Sweden recommended that the reference to tank diameter should be the shell diameter. The expert from OCTI expressed concern that all pressure liquefied gases having critical temperatures below the values in paragraph 12.24.11 (renumbered 12.24.14) are automatically excluded from transport which is not the case in RID/ADR. However, the paragraph was accepted without amendment. The expert from the United States recommended adoption of a minimum thermal factor of 1.5333 kilojoules per hour per square metre per degree Celsius. The expert from France believed this figure to be too conservative and agreed to submit an alternate proposal.

36. In regard to the definition of reference mild steel, the group agreed to take into account the definition used for liquid tanks and possible amendments proposed by the expert from Germany.

37. The expert from the United States proposed the term "filling density" in lieu of "filling ratio". The group accepted the proposal.

38. In paragraph 12.25.1, the expert form the United States requested that the words "technical code recognized by the competent authority" be place in square brackets because he felt that the American Society of Mechanical Engineers, Boiler and Pressure Vessel Code should be used for all Class 2 portable tank construction. The Chairman stated that the issue should be dealt with during the working group meeting scheduled in December 1995. Members were asked to study the United States technical code comparison, provide comments and prepare themselves for future discussions. The expert from the United States agreed to provide additional technical justification.

39. Paragraphs 12.25.2 through 12.25.4 were adopted. In paragraph 12.25.5, the word "lining" was deleted because tanks for Class 2 were not considered to be lined. In 12.25.6, the word "fabricated" was changed to "constructed". As a result, Paragraph 12.3.8 in -/R.595/Add.1 was also amended to include "constructed" in lieu of "fabricated".

40. Paragraphs 12.25.7 through 12.25.9 were adopted.

41. The expert from Germany asked why -/R.646 did not include safety factors based on the dynamic loads in 12.25.9. It was agreed to add a paragraph 12.25.9.1 using the same text as in 12.3.11.1 except that the word "metal" is replaced by "steel" and the word "maximum" was deleted.

42. Regarding paragraph 12.25.11 (renumbered 12.25.10), the expert from Sweden suggested that "...of a protective device approved by the CA" should be deleted since it would be covered under "alternative arrangements", this being in line with the proposal. The Chairman stated that since the methodology for "alternative arrangements" was not clear, the test should be adopted unchanged.

43. 12.25.12 (renumbered 12.25.11) was accepted with the understanding that a specific conductance factor for the global insulation should be established.

44. 12.25.13 was deleted since the text is redundant with 12.25.1.

45. 12.26.1 was adopted as it is but the group noted that it differs from the corresponding paragraph for liquids (see 12.4.1).

46. In paragraph 12.26.2 the phrase "1.3 times MAWP" was placed in square brackets. It was stated by the expert form Sweden that figures and formulas should not appear in the definitions but in the main text.

47. Paragraph 12.26.4 was adopted (and renumbered 12.26.3) but "16 % for fine grained steels" was placed in square brackets since this is new and inconsistent with the liquid paper.

48. Paragraph 12.26.4.1 was adopted (and renumbered 12.26.3.1) since it is identical to 12.4.3.1 with a note that this kind of text should be in the ISO standard and not in a regulation.

49. Paragraph 12.27.1 was adopted. Paragraph 12.27.2 was adopted but "manhole covers" was added and "metal" was replaced by "steel" although the expert of France stated that these thicknesses never affect the gas tank designs.

50. Paragraph 12.27.3 was adopted with "steel" replacing "metal" and "12.26.3" was renumbered as "12.26.4.1".

51. Paragraphs 12.27.4 and 12.5.5.3 to read "There should be no sudden changes to the cylindrical portion of the shell" (the rest deleted).

52. The group moved to agenda item No.5 "Any other business" and discussed the use of fine grain steels in tank construction. The experts of Germany and Spain explained why this kind of steel should be allowed [referencing paper TRANS/WP.15/R.324]. The expert of OCTI stated that RID [but not ADR] has permitted this type of steel for some years. The expert of the UK summarized that this kind of steel was hard to weld, did not pass the bend tests and did not meet the Re/Rm ratio criteria. He then asked why the group was considering its use since it is prohibited by Re/Rm ratio. The Chairman stated that the group should discuss this matter in conjunction with future discussion on the square bracketed text in 12.26.4.

53. Regarding the papers from Argentina and Belgium (INF.29) the group considered some of the comments made in the course of reviewing the liquid paper. In considering the remaining comments, the group felt that the current wording was adequate for safety purposes. The group decided that the Belgium paper was long and lacked justification. The group asked for a formal Belgian paper with reasonable justification for each remark made. A summary of the items discussed in the paper were provided to the expert from Belgium.

54. German paper -/R.624, dealing with filling ratios on gas tanks, was not discussed because the group did not reach the pertinent section of the gas paper text. This paper was deferred to the next meeting.

55. The OCTI representative distributed an informal paper dealing with the rationalized approach and the test pressures assigned to tanks intended to carry volatile liquids. The group decided to consider this paper in December.

56. The Chairman asked all delegates to read the remaining text of the gas paper and to submit written comments [i.e., remarks and questions] to the Chairman and Secretary by mid October 1995 */. A compilation of the comments will be made by the Chairman and sent to participants by November 1995. The Chairman proposed one inter-sessional meeting for the last week of March 1996 preferably in the United States or in Paris. The Sub-Committee's concurrence will be requested.

57. Each delegate received a French paper comparing the US DOT (49 CFR), IMDG Code, UN Recommendations and the ADR/RID requirements for cryogenic tanks. The expert from France indicated that a proposal including proposed harmonized text based on the 4 regulations would be mailed to the delegates before the December meeting.

58. This concluded the fourth meeting of the portable tanks working group.

---

*/ Note by the secretariat : The deadline for submitting proposals is 22 September 1995. Comments submitted after that date may not be circulated as official documents.

Annex 1

AGENDA OF THE WORKING GROUP ON PORTABLE TANKS

1. Finalizing the reading of Chapter 12 (12.19.3 to 12.23) (-/R.595/Add.1, p. 20 to 26)

2. Addressing open questions (-/R.595)

   2.1 Questions only related to the liquid (solid) paper, especially those given in INF. papers, given by information to the group and official paper (-/R.621, -/R.629).

   2.2 Preliminary discussion on the paper -/R.618; discussion on the procedure for establishing the list (12.2); question from Belgium (-/R.608).

   2.3 Questions related to all TC

   3.1 First reading of the gas paper (-/R.646, -/R.624)

   3.2 Procedure for the gas papers

4. Reading the report

5. Any other business.

Annex 2

Draft revised Chapter 12 (paras 12.1 to 12.27.4)

CHAPTER 12

RECOMMENDATIONS ON MULTIMODAL TANK TRANSPORT

12.1 Preamble

12.1.1 The provisions of these Recommendations apply to portable tanks (including tank-containers) intended for the transport of dangerous goods in all Classes except for those of Classes 1 [and 2] by all modes of transport. In addition to the provisions of these Recommendations, and unless otherwise specified, the applicable requirements of the International Convention for Safe Containers (CSC) should be fulfilled by any portable tank which meets the definition of a "container" within the terms of that Convention.

12.1.2 In recognition of scientific and technological advances, the Competent Authority may approve use of alternative arrangements that differ from the provisions specified in this Chapter, but offer at least the equivalent safety with respect to the compatibility with the properties of the substances transported and the equivalent or superior resistance to impact, loading and fire.

12.1.3 These provisions are presented in two parts. The first contains requirements applicable to portable tanks intended for the transport of dangerous goods of Classes [2], 3, 4, 5, 6, 7, 8 and 9. The second comprises tables of dangerous goods showing the particular requirements which modify or supplement the requirements of Part I for each particular substance. Table[s] [12.1] and 12.2 of Part II will be required to be brought up to date from time to time by the possible addition of new substances and in the light of technical progress.

12.2 Definitions for Classes [2], 3 to 9

12.2.1 For the purpose of the portable tank requirements relevant to substances in Classes [2], 3, 4, 5, 6, 7, 8 and 9:

12.2.2 "Portable tank" means a multimodal tank having a capacity of more than 450 litres used in the transport of dangerous substances of classes 3 through 9. The tank includes a shell fitted with service equipment and structural equipment necessary for the transport of dangerous substances. The portable tank should be capable of being loaded and discharged without the need of removal of its structural equipment. It should possess stabilizing members external to the shell, and should be capable of being lifted when full. It is designed primarily to be loaded onto a transport vehicle or ship and is equipped with skids, mountings, or accessories to facilitate mechanical handling. Road tank-vehicles, rail tank-wagons, non-metallic tanks and intermediate bulk containers (IBCs) are not considered to fall within the definition for portable tanks.

12.2.3 Shell means the tank proper, including openings and their closures, but does not include service equipment (see 12.2.4).

12.2.4 Service equipment of a shell means measuring instruments and filling, discharge, venting, safety, heating, cooling and insulating devices.

12.2.5 Structural equipment means the reinforcing, fastening, protective or stabilizing members external to the shell.

12.2.6 Maximum allowable working pressure means a pressure that is not less than the higher of the following two pressures measured at the top of the tank while in operating position:

(a) the highest effective pressure allowed in the shell during filling or discharge; or

(b) the maximum effective gauge pressure to which tanks for liquids should be designed which is the sum of the following partial pressures minus 1 bar:

(i) the absolute vapour pressure of the substance in bar at 65°C;

(ii) the partial pressure (in bar) of air or other gases in the ullage space being determined by a maximum ullage temperature of 65°C and a liquid expansion due to the increase of the bulk mean temperature of t_r-t_f (t_f = filling temperature usually 15°C, t_r = 50°C maximum bulk temperature).

12.2.7 Design pressure means the pressure used, according to a recognized pressure vessel code. The design pressure should never be less than the highest of the following three pressures:

(a) the pressure in 12.2.6 (a); or

(b) the pressure in 12.2.6 (b) and the dynamic head pressure determined on the basis of the dynamic forces due to inertia specified in 12.3.10; such a dynamic head pressure should never be taken less than 0.35 bar; or

(c) the required minimum test pressure as specified in Table 12.2, divided by 1.5.

12.2.8 Test pressure means the maximum gauge pressure at the top of the tank taken during the hydraulic pressure test equal to at least 1.5 times the design pressure. The minimum test pressure for portable tanks used for specific substances is given in column 5 in Table 12.2.

12.2.9 Filling pressure means the highest pressure actually built up in the shell when it is being filled.

12.2.10 Discharge pressure means the highest pressure actually built up in the shell when it is being discharged.

12.2.11 Leakage test means the a test using air or an inert gas which consists of subjecting the shell and its service equipment to an effective internal pressure equivalent to not less than 25 percent and not more than 50 percent of the maximum allowable working pressure.

12.2.12 Total mass means the mass of the shell, service equipment and structural equipment and the heaviest load authorized for transport.

12.2.13 Reference [Mild] steel means a steel with a guaranteed minimum tensile strength of 370 N/mm^2 and a guaranteed minimum elongation of 27%.

12.2.14 Design temperature range is considered to be -20°C to 50°C for substances transported under ambient conditions. For substances handled under elevated temperature conditions the design temperature should be at least equivalent to the maximum temperature of the substance during loading, discharge or transport. More severe design temperatures should be considered for portable tanks subjected to severe climatic conditions.

12.3 [General requirements for the design, construction and operation of portable tanks for substances of Classes 3 to 9]

12.3.1 Shells should be designed and constructed in accordance with the provisions of a technical code recognized by the competent authority. Shells should be made of metallic materials suitable for shaping. The materials should in principle conform to nationally or internationally recognized material standards. For welded shells only a material whose weldability has been fully demonstrated should be used. Welds should be skillfully made and afford complete safety. In choosing the material the design temperature range should be taken into account with respect to risk of brittle fracture, to stress corrosion cracking and to resistance to impact. Aluminum may only be used as a construction material when indicated in Table 12.2 of Part II for the substance to be transported. Tank materials should be suitable for the external environment in which they may be carried.

12.3.2 Portable tank shells, fittings, and pipework should be constructed of material which is:

(a) substantially immune to attack by the substance carried; or
(b) properly passivated or neutralized by chemical reaction; or
(c) lined with corrosion-resistant material directly bonded to the material of the tank shell or attached by equivalent means.

12.3.3 Gaskets should be made of materials not subject to attack by the contents of the portable tank.

12.3.4 The lining of a portable tank should meet the following:

(a) the material used to line the tank should be:

(i) substantially immune to attack by the substances to be transported;

(ii) homogeneous;

(iii) non porous;

(iv) free from perforations;

(v) sufficiently elastic; and

(vi) have thermal expansion characteristics compatible with the tank shell.

(b) the lining of the tank, tank fittings and piping should be:

(i) attached by bonding or other satisfactory means;

(ii) continuous; and

(iii) extended around the face of any flange.

(c) joints and seams in the lining should be made by fusing the material together or by other equally effective means.

12.3.5 Contact between dissimilar metals which could result in damage by galvanic action should be avoided.

12.3.6 The materials of the tank, including any devices, gaskets, linings and accessories, should not adversely affect the contents of the tank.

12.3.7 Portable tanks should be designed and constructed with supports to provide a secure base during transport and with suitable lifting and tie-down attachments.

12.3.8 Shells, their attachments and their service and structural equipment should be designed to withstand, without loss of contents, at least the internal pressure due to the contents, and the static, dynamic and thermal loads in normal handling and transport.

12.3.9 Portable tanks without vacuum relief valves should be designed to withstand without permanent deformation an external pressure at least 0.4 bar above the internal pressure. Tanks equipped with vacuum-relief valves should be designed to withstand, without permanent deformation, an external over-pressure of 0.21 bar gauge or greater and should have their vacuum-relief valve set to relieve at minus (-) 0.21 bar gauge. A greater negative setting may be used provided the external design pressure is not exceeded. All vacuum-relief devices used on tanks for the transport of liquids meeting the flashpoint criteria of Class 3, or elevated temperature materials transported above their flashpoint, should be equipped with a flame trap [or the tank should be explosion pressure proof].

12.3.10 Portable tanks and their fastenings should, under the maximum permissible load, be capable of absorbing the following forces:

(a) in the direction of travel: twice the total mass;

(b) horizontally at right angles to the direction of travel: the total mass (where the direction of travel is not clearly determined, the forces should be equal to twice the total mass);

(c) vertically upwards: the total mass; and

(d) vertically downwards: twice the total mass (total loading including the effect of gravity).

12.3.10.1 Under each of these loads, the safety factors to be observed should be as follows:

(a) for metals having a clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed yield stress; or

(b) for metals with no clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed 0.2 % proof stress and, in the case of austenitic steels, the 1 % proof stress.

12.3.10.1 (cont'd) The value of yield stress or proof stress should be the value according to the material standard. If no material standard exists for the metal or alloy in question, the value of yield stress or proof stress used shall be approved by the competent authority.

When austenitic steels are used, the specified minimum values according to the material standards may be increased up to 15 % if this value is attested to in the material inspection certificate.

12.3.11 Portable tanks intended to contain certain dangerous substances listed in Table 12.2 of Part II should be provided with additional protection, which may take the form of additional thickness of the shell or a higher test pressure, the additional thickness or higher test pressure being determined in light of the dangers inherent of the substances concerned, or of a protective device approved by the competent authority.

12.4 Design Criteria

12.4.1 Portable tank shells should be of a design capable of being stress-analyzed mathematically or experimentally by resistance strain gauges, or by other methods approved by the competent authority.

12.4.2 Portable tanks should be designed and constructed to withstand a hydraulic test pressure equal to at least 1.5 times the design pressure. Specific requirements are laid down for certain substances listed in Table 12.2 of Part II. Attention is drawn to the minimum shell thickness requirements for these tanks specified in 12.5.1 to 12.5.5.3.

12.4.3 At the test pressure, the primary membrane stress σ in the shell should conform to the material-dependent limitations prescribed below.

(a) for metals and alloys exhibiting a clearly defined yield point or characterized by a guaranteed proof stress (0.2 % proof stress generally or 1 % proof stress for austenitic steels), the membrane stress σ at the test pressure should not exceed 0.75 Re or 0.50 Rm, whichever is lower, where:

12.4.3 (cont'd)

Re = yield stress, or 0.2% proof stress or, in the case of austenitic steels, 1% proof stress.

Rm = minimum tensile strength.

The values of Re and Rm to be used shall be the specified minimum values according to the material standards. Where no material standard exists for the metal or alloy in question, the values of Re and Rm used shall be approved by the competent authority or its authorized body. When austenitic steels are used, the specified minimum values according to the material standards may be exceeded by up to 15% if these higher values are attested in the inspection certificate.

Ratios of Re/Rm exceeding 0.85 are not allowed for steels used in the construction of welded tanks. In determining the ratio Re/Rm, the values specified in the material inspection certificate should be used.

The values specified in the material inspection certificate should be as follows:

(b) in the case of steel, the elongation at fracture, in %, should not be less than 10,000/Rm where Rm is in N/mm^2, with an absolute minimum of 20%.

(c) in the case of aluminum, the elongation at fracture, in % should not be less than 10,000/6 Rm where Rm is in N/mm^2, with an absolute minimum of 12 %.

12.4.3.1 For the purpose of determining actual values for materials, it should be noted that in the case of sheet metal, the axis of the tensile test specimen should be at right angles (transversely) to the direction of rolling. The permanent elongation at fracture should be measured on test specimens of circular cross section as follows :

$$Lo = 5\ d$$

where:

Lo = length of the specimen before the test; and

d = diameter.

12.4.3.1 (cont'd) If test specimens of rectangular cross sections are used, the gauge length should be calculated by the formula:

$$Lo = 5.65 (So)^{1/2}$$

where:

So = the initial cross section of the specimen before the test

12.4.4 */ Portable tanks should be capable of being electrically earthed when they are used for the transport of substances meeting the flashpoint criteria of class 3 or elevated temperature materials transported above their flashpoint. Measures should be taken to prevent a dangerous electrostatic discharge.

12.5 Minimum shell thickness

12.5.1 The minimum thickness of a portable tank should be the higher of:

(a) the minimum thickness determined in accordance with the provisions of sections 12.5.2 to 12.5.5.3; and

(b) the minimum thickness determined in accordance with the recognized technical code including the provisions in 12.4.3

12.5.2 The cylindrical portions of the shells, the ends and the manhole covers of tanks not more than 1.80 metres in diameter should be not less than 5 mm thick if of mild steel or equivalent thickness if of other metal. In tanks more than 1.80 metres in diameter they should be not less than 6 mm thick if of mild steel or equivalent thickness if of other metal.

---

*/ Paragraph to be moved at a more appropriate place.

12.5.3 Where additional protection of the tank against damage is provided, the competent authority may authorize for a tank having a test pressure below 2.65/bar, a reduction in the minimum thickness in proportion to the protection provided. However, the cylindrical portion of the shells, the ends and the manhole covers of tanks not more than 1.80 metres in diameter should be not less than 3 mm thick if of mild steel or of equivalent thickness if of other metal, and those of tanks more than 1.80 metres in diameter should be not less than 4 mm thick if of mild steel or of equivalent thickness if of other metal.

12.5.4 The cylindrical portion, the ends and the manhole cover of the tanks in 12.5.2 and 12.5.3 should be not less than 3mm thick regardless of the material of construction.

12.5.5 The additional protection referred to in 12.5.3 may be provided by overall external structural protection, such as suitable "sandwich" construction with the outer shielding secured to the tank, double wall construction or the tank supported in a complete framework with longitudinal and transverse structural members.

12.5.6 The thickness of a metal other than the reference mild steel to that prescribed in 12.5.2 and 12.5.3 should be determined by using the following equation:

$$e_1 = \frac{21.4e_o}{\sqrt[3]{Rm_1 \times A_1}}$$

12.5.5.1 Where in Table 12.2 of Part II, apart from references to the requirements in 12.5.2, a greater minimum thickness is required, it should be mentioned that this given thickness is based on a tank diameter of 1.8 m and on using the reference mild steel . For metals having other characteristics and for tanks having other diameters, these values should be changed using the following equation:

$$e_1 = \frac{21.4e_o d_1}{1.8\sqrt[3]{Rm_1 \times A_1}}$$

where:

e_1 = the required equivalent thickness of the metal to be used in mm

e_o = minimum thickness for mild steel specified in table 12.2 of Part II

d_1 = actual diameter of the tank in metres

Rm_1 = guaranteed minimum tensile strength of the metal to be used in N/mm^2

A_1 = guaranteed minimum elongation (as a percentage) of the metal to be used on fracture under tensile stress (see 12.4.3).

12.5.5.2 In no case should the wall thickness be less than that prescribed in 12.5.2, 12.5.3 and 12.5.4. All parts of the shell should have a minimum thickness as determined by 12.5.2 to 12.5.5. This thickness should be exclusive of any corrosion allowance.

12.5.5.3 There should be no sudden change [of plate thickness at the attachment of the head] to the cylindrical portion of the shell.

12.6 Service equipment

12.6.1 Service equipment should be so arranged as to be protected against the risk of being wrenched off or damaged during transport and handling. If the connection between the frame and the tank shell allows relative movement as between the sub-assemblies, the equipment should be so fastened as to permit such movement without risk of damage to working parts. The external discharge fittings (pipe sockets, lateral shut-off devices), the internal stop-valve and its seating should be protected against the danger of being wrenched off by external stresses (for example using shear sections). The filling and discharge devices (including flanges or threaded plugs) and protective caps (if any) should be capable of being secured against any unintended opening.

12.6.2 All openings in the tank-shell, intended for loading or discharging of the substance, should be fitted with a manually operated stop valve located as near as practicable to the shell. Other openings, except for openings leading to venting or pressure relief devices, should be equipped with either a stop valve or another suitable means of closure located as close as practicable to the shell. There should be no obstruction in an opening leading to a venting or pressure relief device which might restrict or cut-off the flow from the tank to that device.

12.6.3 Each portable tank should be fitted with a manhole or other inspection openings of a suitable size to allow for internal inspection and adequate access for maintenance and repair of the interior. Compartmental tanks should have a manhole or other inspection openings for each compartment.

12.6.4 Whenever possible, external fittings should be grouped together. For insulated tanks, top fittings should be surrounded by a spill collection reservoir with suitable drains.

12.6.5 All tank connections should be clearly marked to indicate the function of each.

12.6.6 Each stop valve or other means of closure should be designed and constructed to a rated pressure not less than the maximum allowable working pressure of the tank and to the temperature expected in transport. Each stop valve with a screwed spindle must be closed by a clockwise motion of the handwheel. In the case of other valves the position and/or direction of closure should be clearly indicated. All valves should be constructed to prevent unintentional opening.

12.6.7 No moving parts, such as covers, components of closures, etc., which are liable to come into frictional or percussive contact with aluminum tank containers intended for the transport of flammable liquids having a flashpoint of not more than 60.5 °C or elevated temperature substances, should be made of unprotected corrodible steel.

12.6.8 All piping should be of suitable metallic material. Welded pipe joints should be used wherever possible. Where copper tubing is permitted, joints should be brazed or have an equally strong metal union. The melting point of brazing materials should be no lower than 525°C. Such joints should in any event be such as not to decrease the strength of the tubing, as may happen by the cutting of threads. Ductile metals should be used in the construction of valves or accessories. The bursting strength of all piping and pipe fittings should be at least four times the strength at the maximum allowable working pressure of the tank and at least four times the strength at the pressure to which it may be subjected in service by the action of a pump or other device (except pressure relief valves) the action of which may subject portions of the piping to pressures greater than the tank maximum allowable working pressure. Suitable provisions should be made in every case to prevent damage to piping due to thermal expansion and contraction, mechanical shock and vibration.

12.7 Bottom openings

12.7.1 Certain substances listed in Table 12.2 of Part II should not be carried in portable tanks with bottom openings. When Table 12.2 in Part II prohibits bottom openings the shell of the tank should not be pierced below the lading level in the tank. When existing openings

are blanked off, this should be by means of suitable blank flanges welded internally and externally to the shell.

12.7.2 Bottom discharge outlets for tanks carrying solids, certain crystallizable or highly viscous substances should be equipped with not less than two serially mounted and mutually independent shut-off devices. The design should satisfy the competent authority, or its authorized body, and should include:

(a) an external stop valve fitted as close to the tank shell as is practicable; and

(b) a liquid tight closure at the end of the discharge pipe, which may be a bolted blank flange or a screw cap.

12.7.3 Every bottom discharge outlet, except as provided in 12.7.2, should be equipped with three serially mounted and mutually independent shut-off devices. The design of the equipment should satisfy the competent authority, or its authorized body and conform to the following:

(a) a self-closing internal stop valve, that is a stop valve within the tank or within a welded flange or its companion flange, such that:

(i) the control devices are so designed as to prevent any unintended opening through impact or other inadvertent act;

(ii) the valve may be operable from above or below; and

(iii) if possible, the setting of the valve (open or closed) should be capable of being verified from the ground.

(iv) It should be possible to close the valve from an accessible position of the portable tank that is remote from the valve itself.

(b) an external stop valve fitted as close to the tank shell as practicable; and

(c) a liquid tight closure at the end of the discharge pipe, which may be a bolted blank flange or a screw cap.

12.7.3.1 In the case of a lined shell, the internal stop valve required by 12.7.3 may be replaced by an external stop valve. The manufacturer should satisfy the requirements of the competent authority or its authorized body.

12.7.4 The internal shut-off device should continue to be effective in the event of damage to the external control device.

12.8 Safety relief

12.8.1 All portable tanks should be fitted with a pressure-relief device. All relief devices should be designed, constructed and marked to the satisfaction of the competent authority or its authorized body.

12.9 Pressure-relief devices

12.9.1 Every portable tank of 1,900 litres or more, or every independent compartment of a tank of similar capacity, should be provided with one or more pressure-relief valve of the spring-loaded type and may in addition have a frangible disc or fusible element in parallel with the spring-loaded devices except when prohibited by reference to 12.9.3 in Table 12.2 of Part II. The pressure relief valves should be designed and have sufficient capacity to prevent tank rupture due to over pressurization or vacuum resulting from loading, unloading, or from heating of the lading.

12.9.2 Pressure-relief devices should be designed to prevent the entry of foreign matter, the leakage of liquid and the development of any dangerous excess pressure.

12.9.3 Tank shells for the transport of certain substances listed in Table 12.2 of Part II should have a pressure relief device approved by the competent authority. Unless a tank in dedicated service is fitted with an approved relief valve constructed of materials compatible with the load, such device should comprise a frangible disc preceding a spring-loaded valve. If a frangible disc is inserted in series with the required pressure relief valve, the space between the frangible disc and the pressure relief valve should be provided with a pressure gauge or suitable tell-tale indicator for detection of disc rupture, pin holing, or leakage which could cause a malfunction of the pressure relief system. The frangible disc should rupture at a nominal pressure 10% above the start to discharge pressure of the relief valve.

12.9.4 Every portable tank with a capacity of less than 1,900 litres should be fitted with a pressure relief device which may be a frangible disc if the latter complies with the requirements of 12.12.1. If no spring-loaded pressure-relief valve is used, the frangible disc should be set to rupture at a nominal pressure equal to the test pressure.

12.9.5 If the tank is fitted with arrangements for air-pressure or inert-gas pressure discharge, the inlet line should be provided with a suitable pressure-relief device set to operate at a pressure not higher than the maximum allowable working pressure of the tank. A stop valve should be provided at the entry to the tank.

12.10 Setting of pressure-relief devices

12.10.1 It should be noted that the devices should operate only in conditions of excessive rise in temperature, as the tank will not during transport be subject to undue fluctuations of pressure due to operating procedures (see, however, 12.13.2).

12.10.2 The required pressure-relief valve should be set to start to discharge at a nominal pressure of the five-sixths of the test pressure in the case of tanks having a test pressure up to and including 4.5 bar and 110 % of two-thirds of the test pressure in the case of tanks having a test pressure of more than 4.5 bar. the valve should, after discharge, close at a pressure not lower than 10 % below the pressure at which discharge starts, and should remain closed at all lower pressures provided that this requirement not be so construed as to prevent the use of vacuum-relief or combination pressure-relief and vacuum relief valves.

12.11 Fusible elements

12.11.1 Fusible elements, if allowed in Table 12.2 of Part II, should function at a temperature between 110°C and 149°C provided that the developed pressure in a tank at the fusing temperature of the element does not exceed the test pressure of the tank. They should be placed at the top of the tank in the vapour space and in no case should they be shielded from external heat. Fusible elements should not be utilized on tanks with a test pressure which exceeds 2.65 bar. Special considerations meeting the satisfaction of the competent authority or its authorized body should be given to fusible elements of tanks used for substances transported at elevated temperatures.

12.12 Frangible discs

12.12.1 Except as provided in 12.9.3, frangible discs, if used should be set to rupture at a nominal pressure equal to the test pressure throughout the design temperature range. Particular attention should be given to the requirements of 12.6.1 and 12.9.3 if frangible discs are used.

12.13 Capacity of relief devices

12.13.1 The spring-loaded pressure relief device required by 12.9.1 should have a minimum diameter of 31.75 mm. Vacuum relief devices, if used, should have a minimum cross sectional flow area of 2.84 cm^2.

12.13.2 The combined delivery capacity of the relief devices in condition of complete engulfment of the tank in fire should be sufficient to limit the pressure in the tank to 20% above the start-to-discharge pressure of the relief device. Emergency pressure-relief devices may be used to achieve the full relief capacity prescribed. Emergency pressure-relief devices may be of the spring-loaded, frangible or fusible type. The total required capacity of the relief devices may be determined by using the formula in 12.13.2.1 or the table in 12.13.2.2.

12.13.2.1 To determine the total required capacity of the relief devices, which may be regarded as being the sum of the individual capacities of the several devices, the following formula may be used:

$$Q = 12.4 \frac{FA^{0.82}}{LC} \sqrt{\frac{ZT}{M}}$$

where: **Q** = minimum required rate of discharge in cubic metres of air per hour at standard conditions: 1 bar and 0°C (273 K);

F = is a coefficient with the following value:

for uninsulated tanks **F** = 1

for insulated tanks **F** = U(649 - t)/13.6 but in no case is less than 0.25 where:

U = thermal conductance of the insulation, in kW/(m^2K), at 38 °C

t = actual temperature of the substance at loading (°C); if this temperature is unknown, let t = 15 °C:

12.13.2.1 (cont'd) The value of **F** given in .2 above may be taken provided that: the insulation is jacketed with a material having a melting point not less than 649 °C; and the insulation system will remain effective at all temperatures up to 649 °C:

A = total external surface area of tank in square meters

Z = the gas compressibility factor in the accumulating condition (if this factor is unknown, let Z equal 1.0);

T = absolute temperature in Kelvin (°C + 273 K) above the pressure-relief devices and in the accumulating condition;

L = the latent heat of vaporization of the liquid, in kJ/kg, in the accumulating condition;

M = molecular mass of the discharged gas;

C = a constant which may be taken from the following Table which is derived from the following equation as a function of the ratio k of specific heats:

$$k = \frac{C_p}{C_v}$$

where :

Cp = the specific heat at constant pressure and

Cv = the specific heat at constant volume;

$$C = \sqrt{k\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}$$

when k > 1

$$C = \frac{1}{e^{0.5}} = 0.607$$

when k = 1 or k is unknown

where:

e = the mathematical constant 2.7183

VALUES FOR THE CONSTANT C WHEN k > 1

k	C	k	C	k	C
1.00	0.607	1.26	0.660	1.52	0.704
1.02	0.611	1.28	0.664	1.54	0.707
1.04	0.615	1.30	0.667	1.56	0.710
1.06	0.620	1.32	0.671	1.58	0.713
1.08	0.624	1.34	0.674	1.60	0.716
1.10	0.628	1.36	0.678	1.62	0.719
1.12	0.633	1.38	0.681	1.64	0.722
1.14	0.637	1.40	0.685	1.66	0.725
1.16	0.641	1.42	0.688	1.68	0.728
1.18	0.645	1.44	0.691	1.70	0.731
1.20	0.649	1.46	0.695	2.00	0.770
1.22	0.652	1.48	0.698	2.20	0.793
1.24	0.656	1.50	0.701		

12.13.2.2 As an alterative to the formula above, tanks designed for the transport of liquids may have their relief devices sized in accordance with the following Table. This table assumes an insulation value of F = 1 and should be adjusted accordingly if the tank is insulated. Other values used in determining this table are:

M = 86.7 T = 394 K
L = 334.94 kJ/kg C = 0.607
Z = 1

MINIMUM EMERGENCY VENT CAPACITY, Q, IN CUBIC METERS PER AIR PER SECOND AT 1 BAR AND 0°C (273 K)

A **Exposed area (square metres)**	**Q** **(Cubic metres of air per second)**	**A** **Exposed area (square metres)**	**Q** **(Cubic metres of air per second)**
2	0.230	37.5	2.539
3	0.320	40	2.677
4	0.405	42.5	2.814
5	0.487	45	2.949
6	0.565	47.5	3.082
7	0.641	50	3.215
8	0.715	52.5	3.346
9	0.788	55	3.476
10	0.859	57.5	3.605
12	0.998	60	3.733
14	1.132	62.5	3.860
16	1.263	65	3.987
18	1.391	67.5	4.112
20	1.517	70	4.236
22.5	1.670	75	4.483
25	1.821	80	4.726
27.5	1.969	85	4.967
30	2.115	90	5.206
32.5	2.258	95	5.442
35	2.400	100	5.676

12.13.2.3 Insulation systems, used for the purpose of reducing the venting capacity, should be approved by the competent authority or its designated approval agency. In all cases, insulation systems approved for this purpose must:

12.13.2.3 (cont'd) (i) Remain effective at all temperatures up to 649°C; and

(ii) Be jacketed with a material having a melting point of 649°C or greater.

12.14 Markings on relief devices

12.14.1 Every pressure-relief device should be plainly and permanently marked with the pressure or temperature at which it is set to discharge and the rated free-air delivery of the device. Where practicable the following particulars should be shown:

(a) the manufacturer's name and the relevant catalogue number;

(b) set pressure, in bar or kPa and rated flow capacity, in standard cubic metres per second;

(c) allowable tolerances at start-to-discharge pressure (frangible disc) and allowable temperature tolerances (fusible elements).

12.15 Connections to pressure-relief devices

12.15.1 Connections to pressure-relief devices should be of sufficient size to enable the required discharge to pass unrestricted to the safety device. No stop-valve should be installed between the tank shell and the pressure-relief devices except where duplicate devices are provided for maintenance or other reasons and the stop-valves serving the devices actually in use are locked open or the stop-valves are interlocked so that at least one of the duplicate devices is always in use. Vents from the pressure-relief devices, where used, should deliver the relieved vapour or liquid to the atmosphere in conditions of minimum back-pressure on the relieving device.

12.16 Siting of pressure-relief valves

12.16.1 Each pressure relief device inlet should be situated on top of the tank in a position as near the longitudinal and transverse centre of the tank as possible. As pressure relief device inlets should be situated in the vapour space of the tank and the devices should be so arranged as to ensure that the escaping vapour is discharged unrestrictedly and in such a

manner that it cannot impinge upon the shell. Protective devices which deflect the flow of vapour are permissible provided the required relief-device capacity is not reduced.

12.16.2 Arrangements should be made to prevent access to the valves by unauthorized persons and to protect the valves from damage caused by the tank overturning.

12.17 Gauging devices

12.17.1 Glass level-gauges, or gauges made of other easily destructible material, which are in direct communication with the contents of the tank should not be used.

12.18 Tank support, frameworks, lifting and tie-down attachments

12.18.1 Portable tanks should be designed and fabricated with a support structure to provide a secure base during transport. The loadings specified in 12.3.10 should be considered in this aspect of design. Skids, frameworks, cradles or other similar devices are acceptable.

12.18.2 The combined stresses caused by tank mountings (e.g. cradles, framework, etc.) and tank lifting and tie-down attachments should not cause excessive stress in any portion of the tank shell. Permanent lifting and tie-down attachments should be fitted to all tanks. Preferably they should be fitted to the tank supports but may be secured to reinforcing plates located on the shell at the points of support.

12.18.3 In the design of supports and frameworks due regard should be paid to the effects of environmental corrosion.

12.18.4 Forklift pockets of portable tanks should be capable of being closed off. The means of closing forklift pockets should be a permanent part of the framework or permanently attached to the framework. Single compartment tanks with a length less than 3.65 meters need not have closed off pockets provided that:

(a) the tanks shell and all the fittings are well protected from being hit by the forklift blades; and

12.18.4 (cont'd) (b) the distance between the centres of the forklift pockets is at least half of the maximum length of the portable tank unit.

12.19 Design approval, inspection and testing of portable tanks

12.19.1 The competent authority or a body authorized by that authority should issue a design approval certificate for any new design of a portable tank. This certificate should attest that a portable tank has been surveyed by that authority, is suitable for its intended purpose and meets the requirements of this chapter. If a series of portable tanks are manufactured without change in the design, the certificate should be valid for the entire series. The certificate should refer to the prototype test report, [the substances or groups of substances allowed to be transported] and an approval number. The approval number should consist of the distinguishing sign or mark of the State in whose territory the approval was granted, i.e. the distinguishing sign for use in international traffic as prescribed by the Convention on Road Traffic, Vienna 1968, and a registration number. Alternative arrangements according to 12.1.2, if any, should be indicated on the certificate. A design approval may serve for the approval of smaller tanks made of materials of the same kind and thickness, by the same fabrication techniques and with identical supports, equivalent closures and other appurtenances.

12.19.2 The prototype test report for the design approval should include at least the following:

- the results of the applicable frame-work test specified in ISO 1496-3: 1991;
- the results of the impact test in 12.19.2.1;
- the results of the initial inspection and test in 12.19.3.1

[12.19.2.1 For portable tanks meeting the definition of container in the CSC, a prototype tank of each design should be subjected to an impact test. The prototype tank should be shown to be capable of absorbing the forces resulting from an impact equivalent to at least 4 times (4 g) the maximum gross mass of the loaded tank at a duration typical of the mechanical shocks experienced in rail transport. The following is a listing of standards describing methods acceptable for performing the impact test:

Association of America Railroads,
Manual of Standards and Recommended Practices,
Specifications for Acceptability of Tank Containers (AAR.600)

Canadian Standards Association,
Highway Tanks and Portable Tanks for the Transportation
of Dangerous Goods
(B620-1977)]

12.19.3 The shell and items of equipment of each portable tank should be inspected and tested before being put into service for the first time (initial inspection and test) and thereafter at not more than five-year intervals (5 year periodic inspection and test) with an intermediate periodic inspection (2.5 year periodic inspection and test) midway in the 5 year periodic inspection and test. An exceptional inspection and test, when necessary according to 12.19.3.5, should be carried out regardless of the last periodic inspection and test.

12.19.3.1 The initial inspection and test of a portable tank should include a check of the design characteristics, an internal and external examination of the tank and its fittings with due regard to the substances to be transported, and a hydraulic pressure test. Before the portable tank is placed into service, a leakproofness test and a test of the satisfactory operation of all service equipment should also be conducted.

12.19.3.2 The 5-year periodic inspection and test should include an internal and external examination and, as a general rule, a hydraulic pressure test. Sheathing, thermal insulation and the like should be removed only to the extent required for reliable appraisal of the condition of the portable tank. If the shell and equipment have been pressure-tested separately, they should be subjected together after assembly to a leakproofness test.

12.19.3.3 The intermediate 2.5 year periodic inspection and test should at least include:

(a) an internal and external examination of the tank and its fittings with due regard to the substances transported;

(b) a leakproofness test;

12.19.3.3 (c) a test of the satisfactory operation of all service equipment.
(cont'd)

However, the internal examination may be waived by the competent authority concerned, or its authorized body, in the case of tanks dedicated to the transport of a single substance.

12.19.3.4 Portable tanks, empty and uncleaned, may be moved after the expiration of the 5 year intervals. In addition, the 2.5 year inspection and test may be carried out within 3 months before and after the specified date.

12.19.3.5 The exceptional inspection and test is necessary when the tank shows evidence of damaged or corroded areas, or leakage, or other conditions that indicate a weakness that could affect the integrity of the tank.

The extent of the exceptional inspection and test should depend on the amount of damage or deterioration of the portable tank. It should include at least the 2.5 year inspection and test according to 12.19.3.3.

12.19.3.6 The internal and external examination should ensure that:

(1) the tank shell is inspected for pitting, corrosion, or abrasions, dents, distortions, defects in welds or any other conditions, including leakage, that might render the tank unsafe for transport;

(2) the piping, valves, heating/cooling system, and gaskets are inspected for corroded areas, defects, and other conditions, including leakage, that might render the tank unsafe for loading, discharge or transport;

(3) devices for tightening manhole covers are operative and there is no leakage at manhole covers or gaskets;

(4) missing or loose bolts or nuts on any flanged connection or blank flange are replaced or tightened;

12.19.3.6 (cont'd)

(5) all emergency devices and valves are free from corrosion, distortion and any damage or defect that could prevent their normal operation. Remote closure devices and self-closing stop valves should be operated to demonstrate proper operation;

(6) linings are inspected in accordance with criteria outlined by the lining manufacturer;

(7) required markings on the tank are legible.

12.19.3.7 The inspections and tests in 12.19.3.1, 12.1.9.3.2, 12.19.3.3 and 12.19.3.5 should be carried out or witnessed by the competent authority or its authorized body.

If the hydraulic pressure test is a part of the inspection and test, the test pressure should be the one indicated on the data plate of the portable tank. While under pressure, the tank should be inspected for any leakages on the shell, piping or equipment.

12.19.3.8 In all cases where cutting, burning or welding operations on the shell of a portable tank have been effected, that work should be to the approval of the competent authority and a hydraulic test pressure to the original test pressure should be carried out.

12.19.3.9 If evidence of any unsafe condition is discovered, the tank should not be placed or returned to service until it has been corrected and the test is repeated and passed.

12.19.4 The design approval certificate, the test report and the certificate showing the results of the initial inspection and test for each tank issued by the competent authority or its authorized body should be retained by the authority or body and the owner. Owners should be able to provide this documentation upon the request of any competent authority.

12.20 Marking

12.20.1 Every portable tank should be fitted with a corrosion-resistant plate permanently attached to the tank in a conspicuous place readily accessible for inspection. If for reasons of tank arrangements, the plate cannot be permanently attached to the shell, the shell should be marked with at least those particulars required by the pressure vessel code. At least the following particulars should be marked on the plate by stamping or by any other similar method.

Country of manufacture

U N Approval COUNTRY - Approval NUMBER - In the case of Alternate Arrangements "AA"

Manufacturer's name or mark.

Manufacturer's serial number

Authorized Body for the design approval

Owner's Registration number

Year of manufacture

[Tank type]

Technical Code to which tank is designed

Hydraulic Test pressure _____ bar gauge

MAWP _____ bar gauge

Water capacity at 20°C _____ litres

Water capacity of each compartment _____ litres at 20°C.
Initial hydraulic pressure test date and witness identification

Design temperature range, _____ °C to _____ °C.

Maximum allowable working pressure for heating/cooling system bar gauge

Tank shell material and material reference

Equivalent thickness in mild steel _____ mm

Lining material (if any)

Date and type of most recent periodic test
Stamp of expert who carried out or witnessed the most recent test.

12.20.2 The following particulars should be marked either on the portable tank itself or on a metal plate firmly secured to the portable tank:

- Name of the operator
- Name of substance being carried (and maximum mean bulk temperature if higher than 50°C)
- Maximum permissible gross mass _____ kg
- Unladen (tare) mass _____ kg

12.20.3 The contents should be identified as specified in Chapter 13 of the Recommendations.

12.21 Transport requirements

12.21.1 During transport, portable tanks should be adequately protected against lateral and longitudinal impact and against overturning. If the shells and the service equipment are so constructed as to withstand impact or overturning they need not be protected in this way. Examples of protection of shells against collision:

(a) protection against lateral impact may consist, for example, of longitudinal bars protecting the shell on both sides at the level of the median line;

(b) protection of portable tank against overturning may consist, for example, of reinforcement rings or bars fixed across the frame;

(c) protection against rear impact may consist of a bumper or frame;

(d) external fittings should be designed or protected so as to preclude the release of contents upon impact or overturning of the tank upon the fittings.

12.21.2 Certain substances are chemically unstable. They are accepted for transport only if the necessary steps have been taken to prevent their dangerous decomposition, transformation or polymerization during transport. To this end, care should in particular be taken to ensure that tanks do not contain any substances liable to promote these reactions.

12.21.3 The temperature of the outer surface of the tank shell excluding openings and their closures or of the thermal insulation should not exceed 70 °C during transport. When dangerous goods are transported at elevated temperatures in either liquid or solid state, the tank must be thermally insulated to meet this condition.

12.21.4 Empty portable tanks not cleaned and not gas-free should comply with the same requirements as tanks filled with the previous substance.

12.22 Filling Ratios

12.22.1 Portable tanks, should be filled to the extent provided for by 12.22.2 to 12.22.5. The applicability of 12.22.2, 12.22.3 or 12.22.5 to individual substances is specified by the reference in Table 12.2 of Part II.

12.22.2 The degree of filling for general use is determined by the formula:

$$\text{Degree of filling} = 97/(1 + \alpha\,(t_r - t_f))$$

12.22.3 Liquids of Division 6.1 or Class 8, in Packing Groups I or II, and also liquids with absolute saturated vapour pressure of more than 1.75/bar at 65°C, should be filled according to the formula:

$$\text{Degree of filling} = 95/(1 + \alpha(t_r - t_f))$$

12.22.4 In these formulae α is the mean of coefficient of cubical expansion of the liquid between the mean temperature of the liquid during filling (t_f) and the maximum mean bulk temperature (t_r), and is calculated by the formula:

$$\alpha = (d_{15} - d_{50})/(35d_{50})$$

in which d_{15} and d_{50} are the density of the liquid at 15°C and 50°C, respectively.

12.22.4.1 The maximum mean bulk temperature (t_r) should be taken as 50°C except that, for journeys in temperate or extreme climatic conditions, the competent authorities concerned may agree to a lower or to a higher temperature, as appropriate.

12.22.5 The provisions of 12.22.1 to 12.22.3 should not apply to portable tanks whose contents are maintained by means of a heating device at a temperature above 50°C during transport. In such a case the degree of filling should be such that, through the action of a temperature regulator, the portable tank is not full to more than 95 % of its capacity at any time during transport.

12.22.6 Portable tanks should not be offered for transport:

(a) with a degree of filling, for liquids having a viscosity of less than 2,680 centistokes at 20°C, of more than 20% but less than 80% unless the shells of portable tanks are divided, by partitions or surge plates, into sections of not more than 7,500 litres capacity;.

(b) with residue of goods carried adhering to the outside of the tank shell or service equipment;

(c) that are leaking or damaged to such an extent that the integrity of the tank or its lifting or securing arrangements may be affected; and

(d) unless the service equipment has been examined and found to be in good working order.

12.23 Handling requirements

12.23.1 Fork-lift pockets of portable tanks should be closed off when the portable tank is filled.

12.23.2 Substances should not be carried in adjoining compartments of tanks if they may react dangerously with each another and cause:

(a) combustion and/or evolution of considerable heat;

12.23.2 (cont'd) (b) evolution of flammable, toxic or asphyxiant gases;

(c) the formation of corrosive substances;

(d) the formation of unstable substances.

(e) dangerous rise in pressure.

12.24 **Definitions for Class 2, [3 to 9]**

12.24.1 For the purposes of the portable tanks requirements relevant to [non refrigerated liquefied gases] [substances] in Class 2, [3, 4, 5, 6, 7, 8 and 9]:

12.24.2 *Portable tank* means a multimodal tank having a capacity of more than [1,000 litres] used in the transport of non-refrigerated liquefied gases of class 2. The tank includes a shell fitted with service equipment and structural equipment necessary for the transport of gases. The portable tank should be capable of being loaded and discharged without the need of removal of its structural equipment. It should possess stabilizing members external to the shell, and should be capable of being lifted when full. It is designed primarily to be loaded onto a transport vehicle or ship and is equipped with skids, mountings, or accessories to facilitate mechanical handling. Road tank-vehicles, rail tank-wagons, non-metallic tanks and large receptacles are not considered to fall within the definition for portable tanks.

12.24.3 *Shell* means the tank proper, including openings and their closures, but does not include service equipment (see 12.24.4).

12.24.4 *Service equipment of a shell* means measuring instruments and filling, discharge, venting, safety and insulating devices.

12.24.5 *Structural equipment* means the reinforcing, fastening, protective or stabilizing members external to the shell.

12.24.6 *Maximum allowable working pressure* (MAWP) means a pressure that is not less than the higher of the following two pressures measured at the top of the tank while in operating position:

.1 the highest effective pressure allowed in the shell during filling or discharge; or

.2 the maximum effective gauge pressure to which tanks should be designed which is:

.2.1 for gases for which the MAWP in bar is given in column (5) in Table 12.1, the appropriate value;

.2.2 for other gases, the sum of the following partial pressures minus 1 bar:

.2.2.1 the absolute vapour pressure of the substance in bar at the design reference temperature;

.2.2.2 the partial pressure (in bar) of gases in the ullage space being determined by the design reference temperature and the liquid phase expansion due to the increase of the bulk mean temperature of t_r-t_f (t_f = filling temperature usually 15°C, t_r = 50°C maximum bulk temperature).

In no case should the MAWP be less than 7 bar [and more than 50 bar].

12.24.7 *Design pressure* means the pressure used, according to a recognized pressure vessel code. The design pressure should never be less than the highest of the following two pressures:

(a) the pressure in 12.24.6.1,

(b) the pressure in 12.24.6.2 and the dynamic head pressure determined on the basis of the dynamic forces due to inertia specified in 12.25.9, such a dynamic head pressure should never be taken less than 0.35 bar.

[(c) the required minimum test pressure as specified in Table 12.1 divided by [1.5]].

12.24.8 *Test pressure* means the maximum gauge pressure at the top of the tank taken during the hydraulic pressure test equal to at least [1.3] times the design pressure.

12.24.9 *Filling pressure* means the highest pressure actually built up in the shell when it is being filled.

12.24.10 *Discharge pressure* means the highest pressure actually built up in the shell when it is being discharged.

12.24.11 *Leakage test* means a test using gas which consists of subjecting the shell and its service equipment to an effective internal pressure equivalent to not less than 25 % but not more than 50 % of the maximum allowable working pressure.

12.24.12 *Total mass* means the mass of the shell service equipment and structural equipment and the heaviest load authorized for transport.

12.24.13 *Reference mild steel* means a steel with a guaranteed minimum tensile strength of 370 N/mm^2 and a guaranteed minimum elongation of 27 %.

12.24.14 *Design reference temperature* means the temperature at which the vapour pressure of the contents is determined for the purpose of calculating the maximum allowable working pressure. The design reference temperature should be less than the critical temperature of the gas to be transported to ensure that the gas at all times is liquefied. This value for each tank type is as follows:

(a) tank with a diameter of 1.5 metres or less: 65°C;

(b) tank with a diameter of more than 1.5 metres:

(i) without insulation or sun shield: 60°C.

(ii) with sun shield: 55°C.

(iii) with insulation: 50°C */.

---

*/ *This reference temperature is provisional and dependent on the quality of the insulation system [define global thermal insulation].*

12.24.15 *Filling density* means the average mass of substance per litre of tank capacity (kg/l). The filling density is given in column (8) in Table 12.1.

12.25 General requirements for the design, construction and operation of portable tanks for non-refrigerated liquefied gases

12.25.1 Shells should be designed and constructed in accordance with the provisions of a [technical code recognized by the competent authority.] Shells should be made of steel suitable for shaping. The material should in principle conform to nationally or internationally recognized materials standards. For welded shells, only a material whose weldability has been fully demonstrated should be used. If the manufacturing process or the materials make it necessary, the shells should be heat-treated with a suitable heat treatment after welding operations. Welds should be skillfully made and afford complete safety. In choosing the material the design temperature range should be taken into account with respect to risk of brittle fracture, to stress corrosion cracking and to resistance to impact. Tank materials should be suitable for the external environment in which they may be carried.

12.25.2 Portable tank shells, fittings and pipework should be constructed of material which is:

(a) substantially immune to attack by the substance carried; or

(b) properly passivated or neutralized by chemical reaction.

12.25.3 Gaskets should be made of materials not subject to attack by the contents of the portable tank.

12.25.4 Contact between dissimilar metals which could result in damage by galvanic action should be avoided.

12.25.5 The materials of the tanks, including any devices, gaskets and accessories, should not adversely affect the contents of the tank.

12.25.6 Portable tanks should be designed and constructed with supports to provide a secure base during transport and with suitable lifting and tie-down attachments.

12.25.7 Shells, their attachments and their service and structural equipment should be designed to withstand, without loss of contents, at least the internal pressure due to the contents, and the static, dynamic and thermal loads in normal handling and transport.

12.25.8 Tanks should be designed to withstand an external pressure of at least 0.4 bar gauge above the internal pressure without permanent deformation. When the tank is to be subjected to a significant vacuum before loading or during discharge it should be designed to withstand an external pressure of at least 0.9 bar gauge above the internal pressure and should be proven to that pressure.

12.25.9 Portable tanks and their fastenings should, under the maximum permissible load, be capable of absorbing the following forces:

(a) in the direction of travel: twice the total mass;

(b) horizontally at right angles to the direction of travel: the total mass (where the direction of travel is not clearly determined, the forces should be equal to twice the total mass);

(c) vertically upwards: the total mass; and

(d) vertically downwards: twice the total mass (total loading including the effect of gravity).

12.25.9.1 Under each of these loads, the safety factors to be observed should be as follows:

(a) for steels having a clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed yield stress; or

(b) for steels with no clearly defined yield point, a safety factor of 1.5 in relation to the garanteed 0.2 % proof stress and, in the case of austenitic stells, the 1 % proof stress.

The value of yield stress or proof stress should be the value according to the material standard. If no material standard exists for the steel in question, the value of yield stress or proof stress used shall be approved by the competent authority.

12.25.9.1 When austenitic steels are used, the specified minimum values according to the (cont'd) material standards may be increased up to 15 % if this value is attested to in the material inspection certificate.

12.25.10 Portable tanks intended to contain certain gases listed in Table 12.1 of Part II should be provided with additional protection, which may take the form of additional thickness of the shell or a higher test pressure, the additional thickness or higher test pressure being determined in the light of the dangers inherent in the substances concerned; or of a protective device approved by the competent authority.

12.25.11 Thermal insulation systems should satisfy the following requirements:

(a) If the shells of portable tanks intended for the transport of gases are equipped with thermal insulation, such insulation should either:

(i) consist of a shield covering not less than the upper third but not more than the upper half of the surface of the portable tank-container and separated from the shell by an air space about 4 cm across; or

(ii) consist of a complete cladding of adequate thickness of insulating materials protected so as to prevent the ingress of moisture and damage under normal transport conditions.

If the protective covering is so closed as to be gas-tight, a device should be provided to prevent any dangerous pressure from developing in the insulating layer in the event of inadequate gastightness of the shell or of its items of equipment.

(b) The thermal insulation should be so designed as not to hinder access to the fittings and discharge devices.

12.26 **Design Criteria**

12.26.1 Tanks should be of a circular cross-section.

12.26.2 Portable tanks should be designed and constructed to withstand a hydraulic test pressure equal to at least [1.3] times the maximum allowable working] design pressure. Specific requirements are laid down for certain substances in Table 12.1 of Part II. Attention is drawn to the minimum shell thickness requirements, for these tanks specified in 12.27.

12.26.3 At the test pressure, the primary membrane stress in the shell should conform to the material-dependent limitations prescribed below.

(a) for steels exhibiting a clearly defined yield point or characterized by a garanteed proof stress (0.2% proof stress generally or 1% proof stress for austenitic steels), the membrane stress at the test pressure should not exceed 0.75 Re or 0.50 Rm, whichever is lower, where:

Re = yield stress, or 0.2% proof stress or, in the case of austenitic steels, 1% proof stress.
Rm = minimum tensile strength.

The values of Re and Rm to be used shall be specified minimum values according to material standards. Where no material standard exists for the steel in question, the values of Re and Rm used shall be approved by the competent authority or its authorized body. When austenitic steels are used, the specified minimum values according to the material standards may be exceeded by up to 15% if these higher values are attested in the inspection certificate. The values specified in the material inspection certificate shall be as follows:

Ratios of Re/Rm exceeding 0.85 are not allowed for steels used in the construction of welded tanks. In determining the ratio Re/Rm, the values specified in the material inspection certificate should be used.

(b) the elongation at fracture, in %, should not be less than $10,000/R_m$ where Rm is in N/mm^2, with an absolute minimum of [16% for fine grained steels and] 20% [for other steels].

12.26.3.1 For the purpose of determining actual values for materials, it should be noted that in the case of sheet metal, the axis of the tensile test specimen should be at right angles (transversely) to the direction of rolling. The permanent elongation at fracture should be taken measured on test specimens of circular cross section as follows:

$$Lo = 5\ d,$$

where: Lo = length of the specimen before the test; and
d = diameter;

If test specimens of rectangular cross section are used, the gauge lenghth should be calculated by the formula:

$$Lo = 5.65\ (So)^{1/2}$$

where: So = the initial cross section of the specimen before the test.

12.27 **Minimum shell thickness**

12.27.1 The minimum thickness of a portable tank, excluding any corrosion allowance, should be the higher of:

a) the minimum thickness determined in accordance with the provisions of sections 12.27.2 to 12.27.4; and

b) the minimum thickness determined in accordance with the recognized technical code including the provisions in 12.26.3.

12.27.2 The cylindrical portions of the shells, the ends and the manhole covers of tanks not more than 1.80 metres in diameter should be not less than 5 mm thick if of mild steel, or equivalent thickness if of other steel. In tanks more than 1.80 metres in diameter they should be not less than 6 mm thick if of mild steel, or equivalent thickness if of other steel. The cylindrical portions, the ends and the manhole covers of all tanks should be at least 4 mm thick regardless of the materials of construction.

12.27.3 The thickness of a steel other than the reference mild steel with a minimum tensile strength of 370 N/mm^2 and with a minimum percentage elongation of 27 equivalent to that prescribed in 12.27.2 should be determined by using the following equation:

$$e_1 = \frac{21.4\ e_0}{\sqrt[3]{Rm_1 \times A_1}}$$

where: e_1 = the required equivalent thickness of the steel to be used in N/mm^2;
e_o = minimum thickness for mild steel specified in 12.27.2;
Rm_1 = guaranteed minimum tensile strengh of the steel to be used in N/mm^2;
A_1 = guaranteed minimum elongation (as a percentage) of the steel to be used on fracture under tensile stress (see 12.26.4).

12.27.4 There should be no sudden changes [of plate thickness at the head of attachment] to the cylindrical portion of the shell.